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(54) ADHESIVE TAPE

(71) We, NORTON COMPANY, a corporation organised and existing under the laws of the State of Massachusetts, United States of America, of 1, New Bond Street, Worcester, Massachusetts, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to adhesive tapes and to their manner of manufacture.

Adhesive tapes over the years have gained ever increasing popularity for various and sundry uses and in particular for the joining together of two members. In general, those tapes other than the so-called "surgical tapes" and the solvent activated adhesive tapes and which are used in industrial applications, as well as home usage, fall into two broad categories, namely, pressure-sensitive and hot melt adhesive tapes.

The terms "pressure-sensitive adhesive" and "hot melt adhesive" have, we believe, achieved a relatively definite meaning in the adhesive art. Thus, as used herein, pressure-sensitive adhesives are those adhesives which are permanently tacky, such tackiness being essentially independent of and not requiring temperature elevation. On the other hand, hot melt or, as they are sometimes called, heat-activated adhesives are those which become tacky only upon temperature elevation and, prior to temperature elevation, are substantially non-tacky or far less tacky than the pressure-sensitive adhesives. These differing characteristics of the two adhesives make the adhesives readily distinguishable from each other irrespective of their particular chemical formulations.

In usage, the so-called hot melt adhesives (HMA), on application of sufficient heat, become tacky and flowable. On removal of the heat, i.e., taking such away, the adhesive mass sets to a hard state by simple cooling. Thus with application of pressure during the time the adhesive is flowable, the adhesive mass can be provided in intimate contact with the objects to be adhesively bonded together and a relatively strong bond results.

Contrasted therewith, pressure-sensitive adhesive masses become bonded to a suitable substrate in general through mere application of pressure. In certain instances, however, as where a more cohesive mass is desired or better adhesion, a cross-linking or curing agent may be included within the adhesive mass and with some of such agents heat may be desirable for initiation of curing.

Although pressure-sensitive adhesives and hot melt adhesives, and tapes manufactured utilizing such have been found suitable for many and various applications, the use of either has not always been found totally satisfactory and, moreover, is attendant with certain disadvantages.

Hot melt adhesive tapes, because they are non-tacky at room temperature, often become displaced in use, and before heat

application, from their desired location. Such dislocation, however, may be unnoticed until after application of heat. At this point, the tape can only be removed, if at all, with some difficulty. Oftentimes, removal results in either the tape or the object to which the tape is being bonded, or both, being torn or otherwise unsatisfactorily impaired. Thus, dislocation of a hot melt adhesive tape may result in an object of no value whatever or at the very least one of lesser value.

Pressure-sensitive adhesive tapes on the other hand, because they are permanently tacky, can be removed from and reapplied to an object numerous times. Although such property permits and ensures more accurate alignment, adhesion between pressure-sensitive adhesive masses and a substrate to which such a tape is applied is often less than desired.

According to the present invention, there is provided adhesive tape comprising a layer of non-tacky hot melt adhesive mass and on a side thereof and in contact therewith a layer of a tacky, pressure-sensitive adhesive mass, the pressure-sensitive adhesive mass being compatible with the hot melt adhesive mass at elevated temperatures so that at elevated temperatures the hot melt adhesive mass will diffuse throughout the pressure-sensitive adhesive mass.

On removal of heat, the hot melt - pressure-sensitive adhesive mass mixture results in a strong bond.

Tapes embodying our invention offer the features found desirable in the two separate types of adhesives that are combined in our invention. At room temperature, the tape has the attributes of a pressure-sensitive adhesive tape. It can be removed from and reapplied to an object as desired. Thus more accurate alignment can be accomplished when, and if, the need arises. On heating, the hot melt adhesive diffuses into the pressure-sensitive adhesive layer. The result is an adhesive layer having the attributes of a hot melt adhesive, whereby a stronger adhesive bond is achieved.

The invention will now be described by way of example with reference to the accompanying drawing which shows in exaggerated thickness a portion of a length of tape embodying our invention.

Shown in the drawing is a portion of a length of a tape product 10 comprising a backing member 11, on the front side of which is adhered a layer of a hot melt adhesive mass 12, and on the back side of which is provided release coating 13. On the front side of the hot melt adhesive mass 12 is provided in contact therewith a layer of pressure-sensitive adhesive 14.

Backing member 11 can, in general, be of any flexible material conventionally used in the manufacture of adhesive tapes. This includes various plastic films, e.g. polyvinyl chloride, polyethylene terephthalate, and cellulose acetate; metal foils such as, e.g. aluminium foil; and fibrous materials such as, merely by way of example, various conventional paper substrates, impregnated or not, as desired. The choice of backing member material for use in the practice of the invention will depend somewhat on the particular tape application as well as the specific hot melt adhesive formulation selected. It should be kept in mind, however, that the backing member material should be able to withstand the temperature required to activate or make flowable the hot melt adhesive. This temperature is widely variable depending on the choice of melt adhesive formulations; however, melt temperatures in the range of 150-400°F. are preferred.

Hot melt adhesives are well known and are widely used, among other application, for fabric mending and in box manufacture. In general, such adhesives are solid, thermoplastic materials or mixtures, which on application of heat are converted to a flowable state having the ability to wet a substrate to which such has been applied, rapidly and thoroughly, and which on simple cooling or with removal of heat achieves high cohesive and adhesive strength.

Examples of hot melt adhesives include those compositions based on coumarone-indene resins; rosin and its derivatives; mineral, vegetable, and petroleum waxes; alkyds and terpene resins; which may, if desired, be modified with higher molecular weight polymers, such as ethyl cellulose, polyvinyl acetate and its derivatives, polybutyl methacrylates, polyethylene, polystyrene and styrene copolymers, and polyisobutylene. Polyethylene, polyvinyl acetate, and polyamides derived from dimerized fatty acids and diamines, are also useful per se in forming hot melt adhesives.

The hot melt adhesives may, if desired, to permit better flexibility, include a plasticizer. Such as are suitable are deemed well known and include, for example, butyl benzyl phthalate, dibutyl phthalate, and dicyclohexyl phthalate.

Pressure-sensitive adhesives which may be found suitable in the practice of our invention include those based on natural rubber, styrene-butadiene rubber, nitrile rubber, polychloroprene or chlorosulfonated polyethylene rubbers, polyvinyl ethers, polyacrylates, tackified with hydrocarbon resins, polyterpene resins, hydrogenated rosin esters, or other thermoplastic tackifying resins. Resins, however, which react to form chemical bonds with the rubber component, such as phenolics or epoxies are

undesirable. Plasticizers and anti-oxidants, may be also incorporated as desired. Fillers may be included in the composition provided they do not form chemical bonds with the resin or rubber component.

In general any combination of hot melt adhesive and pressure-sensitive adhesive may be used in the practice of our invention so long as they remain as separate layers at room temperature and blend together irreversibly on heating and thereafter on cooling remain as a single layer. The pressure-sensitive adhesive should be uncured so as not to interfere with or preclude diffusion and intimate blending of the hot melt adhesive with the pressure-sensitive adhesive. Moreover, as it would, it is believed to be obvious, the pressure-sensitive adhesive selected must be stable at the melt temperature of the hot melt adhesive.

Application of the respective adhesive layers to the backing member is accomplished in accordance with manufacturing techniques well known to those in adhesive tape art. Either or both, of the adhesive layers may be deposited from suitable solvent solutions. In fact, a good indication of the compatibility of the two adhesives at the melt temperature is the solubility of both in the same solvent. The hot melt adhesive may also be deposited, if desired, as a molten mass. In order to achieve the strongest bond, the hot melt adhesive layer should be at least as thick, and for some applications, thicker than the overcoat of pressure-sensitive adhesive. The desired relative thicknesses, however, depend somewhat on the specific combination of hot melt and pressure-sensitive adhesive. Optimum relative thicknesses for the ultimate bond strength required can be readily ascertained for any particular combination by making a few of such tapes in the laboratory and determining the respective adhesive characteristics.

The following examples are intended to illustrate but not to limit the scope of the invention:

Example 1

A mixture of 40 parts by weight (p.b.w.) high molecular weight ethylene-vinyl acetate copolymer of approximately 25-30% vinyl acetate content and having a melt index of 5-7 (Elvax 260 — E. I. DuPont de Nemours & Co.) (ELVAX is a Registered Trade Mark) and 60 p.b.w. of polystyrene resin having a melting point of 75°C. and a molecular weight of about 400 (Piccolastic A-75 —Pennsylvania Industrial Chemical Corp.) were dissolved in 180 p.b.w. toluene. Sufficient solution thus prepared was coated on 1 mil gauge polyethylene terephthalate film to yield, on drying, 4 mil hot melt adhesive coating.

A pressure-sensitive adhesive composition was then prepared consisting of 100 p.b.w. previously milled pale crepe rubber, 75 p.b.w. 70°C. melting point polyterpene tackifying resin (Piccolyte S70—Penn. Ind. Chem. Co.) (PICCOLYTE is a Registered Trade Mark), 5 p.b.w. petroleum oil (Primol D—Humble Oil & Refining Co.), and 2 p.b.w. polymerized trimethyl dihydroquinoline (Flectol H—Monsanto) (FLECTOL is a Registered Trade Mark) dispersed uniformly in 400 p.b.w. toluene. This composition was coated to a dry thickness of 1.2 mils over the above-described hot melt coating.

The adhesive tape thus manufactured was determined to have a 180° peel adhesion to stainless steel (ASTM-D-1000) of 28-32 oz./in. width, and was readily removable from and replaceable on steel, glass, and polymethyl methacrylate. However, such tape, when adhered to, e.g. stainless steel and heated for 1 minute at 275°F. in a convection oven on cooling to room temperature was determined to have an adhesion of 110-120 oz./in. This level of adhesion is considered "permanent".

Example 2

A 4 mil gauge rope paper was saturated to 100% by weight pickup with the following formulation applied as a 10% by weight solution in 1:1 toluene:methyl ethyl ketone:

	Parts by Weight
Butadiene-Acrylonitrile rubber (Hycar 1001—B. F. Goodrich Chem. Co.)	100
Zinc Oxide	5
Sulfur	2
Stearic Acid	1
Benzothiazyl Disulfide (Altax—R. T. Vanderbilt)	2
Di-ethylhexyl Phthalate	10

(HYCAR and ALTAX are Registered Trade Marks)

Afterwards, the saturated paper was subjected to a temperature of 280°F. for 30 minutes in order to cure the saturating composition.

A hot melt adhesive, as in Example 1, was then coated (without solvent) at 275°F. on the above-prepared backing member. The thickness of the hot melt adhesive coat was 5 mils.

Over the hot melt adhesive layer was then coated a pressure-sensitive adhesive composition as in Example 1 except that such composition also included 35 parts by weight zinc oxide. On drying, the thickness of the pressure-sensitive adhesive layer was approximately 2.3 mils.

The peel adhesion of this tape was determined to be 36-40 oz./in. width. On heating for 10 seconds at 300°F. and 5000 psi pressure, adhesion of this tape (with stainless steel) required 130-150 oz./in. peel removal force at 12 in./min.

Example 3

A hot melt adhesive composition was prepared by admixing together 50 parts by wt. high molecular weight (3500) polystyrene resin (Piccolastic E-100—Penn. Ind. Chem. Co.) and 50 p.b.w. low molecular weight (300) polystyrene resin (Piccolastic A-5) in 200 p.b.w. toluene. Such composition was then coated to a dry thickness of 2.5 mils on 3 mil rolled aluminum foil.

Previously milled (100 p.b.w.) butadiene-styrene rubber (70:30 ratio; SBR 1022), 50 p.b.w. hydrogenated rosin ester (Stabelite 10—Hercules Powder Co.), 10 p.b.w. lanolin, and 2 p.b.w. phenyl-beta-naphthylamine were dispersed uniformly in 450 p.b.w. toluene to provide a desired pressure-sensitive adhesive composition. This was coated over the hot melt adhesive layer to a dry thickness of 2.5 mils.

This tape had a 180° peel adhesion of 42-44 oz./in. width. After 10 seconds at 200°F. in a conventional press at 5000 psi, the peel adhesion was determined to be 90-100 oz./in. width.

Example 4

The hot melt and pressure-sensitive adhesives of Example 1 were coated on 2 mil unplasticized polyvinyl chloride film, each to a dry thickness of 2.5 mils. Adhesion to stainless steel was 36-40 oz./in.. After 30 seconds at 200°F. under 1500 psi, the peel adhesion was found to be 100-110 oz./in..

The combination tapes disclosed herein may, as specifically indicated in Example 1, be applied to a substrate and, while still at room temperature, be removed therefrom and repositioned if the need arises, and then permanently bonded to the substrate with application of heat. The hot melt adhesive component, on blending into the initially solely pressure-sensitive adhesive layer, will ultimately flow down into intimate contact with the substrate and develop an extremely strong bond. Such feature is of particular advantage in the splicing together of certain materials having a very coarse bonding surface.

Tapes manufactured in accordance with the invention may, as shown in the drawing, be provided with a release coating. However, if such be preferred a release liner rather than a coating can be used. The tapes may be made without either a release coating or a release liner. Release coatings and liners are well known and require no detailed description herein. If a release coating is employed, it may be a silicone polymer such as described in United States Patent Specification No. 2,985,554 or one of those commercially available such as Dow-Corning "Syl-off 22". Various release liners are available commercially. In the event a release liner is used, the combination of hot melt and pressure-sensitive adhesive coatings may be applied to only one or both surfaces of the backing member.

Other embodiments of the invention do not include a backing member. The hot melt adhesive composition can be coated directly onto a suitable release liner, then coated over with the desired pressure-sensitive adhesive composition. Thus, a so-called "transfer tape" is provided suitable for use in, e.g. overlap splicing.

WHAT WE CLAIM IS:—

1. Adhesive tape comprising a layer of non-tacky hot melt adhesive mass and on a side thereof and in contact therewith a layer of a tacky, pressure-sensitive adhesive mass, the pressure-sensitive adhesive mass being compatible with the hot melt adhesive mass at elevated temperatures so that at elevated temperatures the hot melt adhesive mass will diffuse throughout the pressure-sensitive adhesive mass.

2. Tape according to claim 1 in which the hot melt adhesive layer is in contact with a release liner, whereby the tape is a transfer tape suitable for use in forming a desired splice between two members to be joined together.

3. Tape comprising a backing member having adhesive layers according to claim 1 on a front side thereof, with the hot melt adhesive mass adjacent the backing member.

4. Tape according to claim 3 wherein on the back side of the backing member is a release composition.

5. Tape according to claim 3, wherein the backing member is provided on its back side, as well as on its front side, with adhesive layers according to claim 1.

6. Tape according to claim 5, wherein a release liner is applied over the outer surface of the combination of adhesive layers provided on one side of the backing member.

7. Tape according to any of claims 3 to 6 wherein the backing member is polyethylene terephthalate film.

8. Tape according to any of claims 3 to 6 wherein the backing member is polyvinyl chloride film.

9. Tape according to any of claims 3 to 6 according to claim 6 wherein the backing member is rope paper saturated with a composition comprising butadiene-acrylonitrile rubber.

10. Tape according to any preceding

claim wherein the hot melt adhesive mass comprises an ethylene-vinyl acetate copolymer.

11. Tape according to any preceding claim wherein the pressure-sensitive adhesive mass comprises natural rubber and a tackifying resin.

12. Tape according to any of claims 1 to 10 wherein said hot melt adhesive comprises polystyrene and the pressure-sensitive adhesive comprises butadiene-styrene rubber and a tackifying agent.

13. Adhesive tape substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

14. Adhesive tape substantially as hereinbefore described with reference to any of the foregoing examples.

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1 SHEET

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.